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HumRRO

Development of Interactive Videodisc Training for Army Land Navigation Skills

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Congress, the Department of Defense, and the Services are emphasizing the application of advanced technology to solve military training problems and to improve training effectiveness. The tank commander (TC) of the Army's new M1 Abrams Tank is a high priority target for this advanced technology application; within the repertoire of TC skills, the Army identified land navigation as the first training segment topic. The objective of this project was to develop and implement computer-based, interactive videodisc training in land navigation for the M1 Abrams tank commander.

Since 1980, HumRRO has conducted a project to develop and evaluate applications of advanced multimedia technology for Army education. The most promising, selected for the majority of the instructional delivery, was a low-cost microcomputer-controlled, interactive videodisc system. The emphasis of the instructional content was basic skills,

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with modules that trained spatial orientation and navigational skills, study and test-taking skills, problem solving, and other learning strategies. The spatial orientation and navigational material, one of the most successful modules, was ideally matched with the vicarious travel capabilities of the interactive videodisc system. Thus, the approach in this task was to refine the interactive videodisc instruction in land navigation to meet the needs of the tank commander.

This report describes the development and implementation of computer-based, interactive videodisc training in land navigation for students in the M1 Abrams tank BNCOC (19K). keywords: 3 4 from AJ 1472

The products of this project are a two-sided videodisc; side one titled "NCO Land Navigational Skills" and side two titled "Map Reading Skills," and the related instructional software to teach the following tasks:

Identify Terrain Features and Determine Elevation
Orient a Map by Terrain Association
Determine a Location on the Ground by Terrain Association
Locate a Point by Intersection or Resection
Analyze Terrain Using Five Military Aspects of Terrain

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ACKNOWLEDGEMENTS

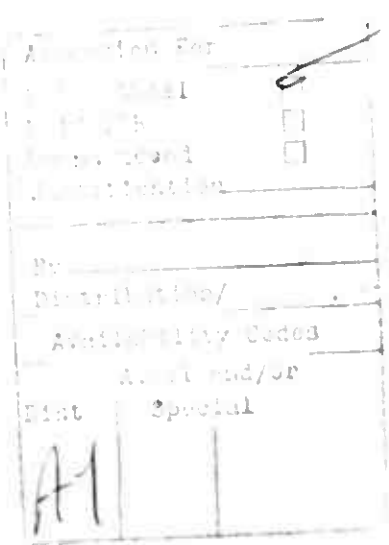
This report describes the development and implementation of computer-based interactive videodisc training in land navigation for the M1 Abrams tank commander.

The work was conducted by the Human Resources Research Organization (HumRRO) under contract to the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Prime Contract MDA903-83-C-0453, ARPA Order Nr. 4069. Dr. Harold O'Neil was the Contracting Officer's Representative (COR). Dr. Donald Haggard was the assistant COR.

The HumRRO Project Director for the work reported here was Dr. C. Mazie Knerr. HumRRO personnel who assisted in this project were Peter Ramsberger, Harold Hunter and Beverly Hunter. The final manuscript was prepared by Theresa Doty. Also assisting were Carl Lickteig, Donald Kristiansen, Ruth Phelps, Debbi Gray and Jackie Campbell from ARI and Billy L. Burnside from TRADOC.

HumRRO was assisted in the project by two subcontractors-Video Software Associates (VSA) and Interactive Television Corporation (ITC). VSA personnel assisting were David Hopwood, Bob Korn and Susan Brooks. ITC personnel assisting were Allen Clark and Nick Atiyeh.

The authors would like to acknowledge the contribution of the original HumRRO videodisc group and their supporting subcontractors. Robert Seidel and Harold Wagner were the original principal investigators, and are largely responsible for the research and development plans that led to the current work. HumRRO personnel who produced interactive videodisc instruction in the early phases of the project were William Underhill, Carol Hargin, Peter Ramsberger, Catherine Wetherby, Judy Pumphrey, David Hannaman, Richard Rosenblatt, and Russel Schulz. The supporting subcontractors were David Hopwood, President of VSA, and Steven Levin, Director of ITC.



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Per Ms. Pat Bender, HumRRO

INTERACTIVE VIDEODISC TRAINING FOR ARMY LAND NAVIGATION SKILLS

EXECUTIVE SUMMARY

Technical Problems:

Congress, the Department of Defense, and the Services are emphasizing the application of advanced technology to solve military training problems and to improve training effectiveness. The tank commander (TC) of the Army's new M1 Abrams tank is a high priority target for this advanced technology application; within the repertoire of TC skills, the Army identified land navigation as the first training segment topic.

Recent training development by the Human Resources Research Organization (HumRRO) produced spatial orientation and navigational skills training implemented on computer-based, interactive videodisc systems (Ramsberger, Hopwood, Hargin, & Underhill, 1983). Experimental and field evaluations demonstrated that the spatial and navigational training materials trained effectively (Ramsberger, Sticha, Knerr, Elder, Rosenblatt, Paris, Wagner, & Leopold, (1984). Development of land navigation training materials, tailored for the M1 TC and based on these successful products, was selected to support the advanced technology initiatives in the Department of Defense.

Objective:

The objective was to develop and implement computer-based, interactive videodisc training in land navigation for the M1 Abrams tank commander.

Approach:

Since 1980, HumRRO has conducted a project to develop and evaluate applications of advanced technology for Army education. The most promising, selected for the majority of the instructional delivery, was a low-cost, microcomputer-controlled, interactive videodisc system. The emphasis of the instructional content was basic skills, with instructional modules that trained spatial orientation and navigational skills, study and test-taking skills, problem solving, and other learning strategies. The spatial orientation and navigational materials were ideally matched with the vicarious travel capabilities of the interactive videodisc system. Therefore, the approach in developing this training was to refine the interactive videodisc instruction in land navigation to meet the needs of the M1 tank commander.

Results and Conclusions:

Interactive videodisc computer-assisted instruction was developed on land navigation tasks for the M1 tank commander. A two-sided videodisc was developed to support the Computer Assisted Instruction (CAI). The CAI courseware was developed on the sponsor selected instructional delivery system, Hazeltine Corporation's Micro TICCIT, which uses the ADAPT authoring language. The completed courseware was installed on a MicroTICCIT system in a designated Basic Noncommissioned Officer's Course (BNCOC) classroom at Fort Knox, Kentucky.

Use of Findings:

The land navigation CAI should be implemented as a part of the 19K BNCOC program of instruction.

The CAI should be expanded to cover other tasks related to land navigation skills and integrated into a complete land navigation course for the tank commander.

The developed CAI should be transferred to a delivery system that offers greater control of videodisc operation. Transfer of material would allow the courseware to be structured more simply, and would lead to more reliable operation.

INTERACTIVE VIDEODISC TRAINING FOR ARMY LAND NAVIGATION SKILLS

CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Background

The Army Training and Doctrine Command (TRADOC), the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), and the U.S. Army Armor Center (USAARMC) established a Training Technology Field Activity (TTFA) at Fort Knox, Kentucky, to improve the effectiveness and efficiency of training through applications of advanced technology. Its initial focus was the Basic Noncommissioned Officer's Course (BNCOC) for training M1 tank commanders (TC) who hold the military occupational specialty (MOS) 19K. One of the primary technologies selected for implementation by the TTFA was computer-based instruction (CBI), which includes computer-assisted instruction (CAI).

The TTFA hypothesized linkages between the 19K BNCOC course elements and potentially relevant technologies. Land navigation is one of the key course elements. More than two decades of military training in map reading and land navigation have not significantly improved soldier performance in these areas. Over 70 percent of soldiers were estimated to be unable to read a map in the 1950s (Marshall, 1979). Recent test scores continue to show low levels of map reading skills. In BNCOC prerequisite tests, only 56 percent of entering students passed land navigation in early course cycles. New instructional concepts, methods, and technologies were needed to improve this training area. The technologies suggested by the TTFA cover those immediately available and others not presently available. Those immediately available include computer-assisted instruction and videodisc systems; combined, these technologies offer powerful adaptive training well suited for land navigation and map reading skill learning.

Approach

Since 1980, the Human Resources Research Organization (HumRRO) has conducted research and development in applications of advanced multimedia technology for Army education. The work concentrated on use of low-cost, microcomputer-controlled, interactive videodisc systems for instructional delivery. The emphasis of the instructional content was basic skills, with modules that trained spatial orientation and land navigational skills, study and test-taking skills, problem solving, and other learning strategies. The spatial orientation and navigational material, one of the most successful modules, was ideally suited for the vicarious travel capabilities of the interactive videodisc system. Therefore, the approach to this work was to refine the interactive videodisc instruction in land navigation to meet the needs of the tank commander.

Spatial Skills Training

Spatial abilities are basic to performance on navigation tasks. Levine, Schulman, Brahlek, and Fleishman (1980, p. 1) suggested that training an ability might prove to be a "more efficient approach...than...training each specific task." However, the question of whether spatial abilities are trainable has not been answered convincingly. Studies on the effects of training in spatial visualization, for example, have yielded mixed results.

One study investigated the feasibility of training spatial visualization so as to "facilitate transfer among tasks requiring these abilities" (Levine, et al., 1980, p. 1). Subjects received extensive practice with feedback on a set of tasks requiring spatial visualization. They were then tested on two transfer tasks that also required spatial visualization. The results indicated no evidence of transfer of training.

A number of studies have reported increases in performance following training in spatial ability. In 1955, Blade and Watson suggested that low spatial visualization ability may be due to a lack of related experience. More recently, Blatter (1983) found evidence that supports this hypothesis. She found that subjects with low spatial abilities benefited more from training than those with high spatial abilities. She concluded that low spatial ability may be due in part to a lack of related experience and training. In contrast, Simutis and Barsam (1983) found that only above average subjects were able to benefit differentially from interactive graphics training. Thus, although spatial skills training may be able to raise the level of performance on spatial tasks, there exist individual differences in training effectiveness.

Other research has shown that self-produced movement through the environment is critical for spatial skills acquisition. Goldin and Thorndyke (1981) demonstrated that navigation provides a unique, procedural kind of knowledge which cannot be acquired by simply reading maps. Cohen (1980) found that information derived from simulated travel through space can be even more effective than actual navigation because of the greater degree of control over information available.

One of the most important cognitive skills in map interpretation is orientation ability (Tkacz, Paulson, Hirsch, and Morris, 1986). This includes processing both cardinal directions and relationships between objects. In addition, field performance depends on such components as identifying natural terrain features on maps, terrain association of map and real world features, and basic map readings skills, such as determining grid coordinates.

Given the evidence cited, it is reasonable to believe training exercises that simulate navigation dynamically will be effective for some initial ability levels. The land navigation

training tasks described in this report include skills found to be important in map interpretation and terrain association performance.

Objective

The objective was to develop and implement computer-based, interactive videodisc training in land navigation for students in the M1 tank BNCOC (19K MOS).

DESIGN OF COMPUTER-ASSISTED INSTRUCTION

The approach for achieving the computer-assisted instruction (CAI) objective is based on TRADOC Regulation 350-7, A Systems Aporoach to Training (SAT) (1982), which specifies the major training design and development phases: analyze, design, develop, implement, and evaluate. An interim report (Knerr, Sticha, Elder, Ramsberger, Harris, & Tkacz, 1984) describes the task analyses and training designs which were prerequisite to the development of the land navigation CAI courseware. The instructional design and development were tailored using the special features available through videodisc-based instruction and Hazeltine corporation's MicroTICCIT authoring and instructional delivery. A glossary is included at the end of this report.

The Land Navigation Training Steering Committee convened by the ARI field unit at Fort Knox specified the land navigation tasks for which task analyses and training designs were accomplished. The committee identified three terminal objectives for the land navigation program: navigate from one point to another, on roads and cross-country, mounted, using a map; determine six-digit grid coordinates; conduct a map reconnaissance to identify and select avenue of approach and positions. Several tasks, viewed as enabling objectives, support these terminal objectives. The committee then determined which ones should be trained, how they should be trained (classroom, videodisc, or field exercise) and where they should be evaluated. Table 1 summarizes the results. These recommendations guided the task analysis and training design.

Through coordination with ARI and the Land Navigation Training Steering Committee, due to contract budgetary restrictions, the number of tasks for which training would be developed was reduced to the following five tasks:

1. Analyze terrain using five military aspects of terrain.

2. Identify natural terrain features and determine elevation.

3. Orient a map to ground by map-terrain association.

4. Determine location on the ground by terrain association.

5. Locate an unknown point on a map or on the ground by intersection or resection.

Traditional task analysis techniques were applied to the objectives, standards, conditions, performance steps, and existing materials of the selected tasks. The results of these analyses guided prescription of the training designs, which used the Training Effectiveness and Cost Effectiveness (TECEP) model. The TECEP model has been incorporated into the Army's procedures for instructional design (TRADOC, 1975).

Table 1

Land Navigation Training Tasks

Tasks	Recommended Location	Recommended Method
a. Analyze terrain using five military aspects of terrain	Classroom	Videodisc
b. Use marginal information, identify topographic symbols and identify adjoining map sheets	Classroom	Instructor
c. Identify natural terrain features and determine elevation	Classroom	Videodisc
d. Determine azimuth using protractor and compute back azimuth (training in angle estimation to be included)	Classroom Field	Instructor [crawl] Instructor [walk; run]
e. Orient a map to the ground by map-terrain association	Outside of Classroom Field	Instructor [crawl] Instructor [walk; run]
f. Determine location on the ground by terrain association	Classroom	Videodisc
g. Determine directions using field expedient methods	Classroom	Videodisc
h. Locate an unknown point on a map or on the ground by intersection or resection	Classroom Field	Videodisc [crawl] Instructor [walk; run]
i. Navigate from one point to another with a map in a vehicle moving at 9 km/hour	Field [introduction] Classroom Field	Instructor [crawl] Videodisc [walk] STX [run]
j. Determine the grid coordinate of a point on a map using military grid reference system	Study Hall	Videodisc

TECEP translates task descriptions and learning principles into prescriptions for learning. The task descriptions (from traditional task analysis) are used to categorize the tasks. The categories differ somewhat over the editions of TECEP, but the categories used in the Army's model are:

Mental	Identifying objects and symbols Recalling information Discriminating, detecting, monitoring Rule learning and using Decision making
Physical	Gross motor skills Responsive motor skill, steering, guiding Positioning movements, recalling procedures Voice communicating

Classification of the tasks into the TECEP categories leads to training prescriptions by applying the learning guidelines and instructional algorithms supplied in the TECEP model. The rules for the training prescriptions are based on the task characteristics, trainee ability levels, and training phase. Some learning guidelines apply to all of the task types, while others apply only to tasks within a specified category.

The TECEP learning guidelines and algorithms specify for each type of task the design considerations, including practice, feedback and reinforcement, guidance and prompts, learning strategies (e.g., mnemonics, imagery), and changes in the training design to enhance various stages of learning. These learning guidelines were determined for each skill type identified, and the land navigation tasks were sequenced into a training package.

Table 2 lists the land navigation tasks selected for training on MicroTICCIT and the TECEP learning guidelines for each task. (The learning guidelines are presented in Appendix A.) A summary of the instructional design for each of the land navigation tasks follows. The instruction and video images are presented to the student by MicroTICCIT on the monitor at the students workstation.

Analyze terrain using the five military aspects of terrain. This lesson is presented using color drawings and pictures of armored vehicles situated to demonstrate the teaching points. The instruction stresses the use of "OCOKA" (O - observation and fire, C - concealment and cover, O - obstacles, K - key terrain, A - avenues of approach) to remember the five aspects, the meaning of each of the aspects, and provides practice in analyzing the terrain in visual battle situations.

Table 2

Land Navigation Tasks and Learning Guidelines

Tasks	TECEP Learning Guidelines
1. Analyze Terrain Using Five Military Aspects of Terrain	
a. Observation and Fire b. Concealment and Cover c. Obstacles d. Key Terrain Features	Rule Learning and Using Classifying and Recognizing Patterns
e. Avenues of Approach	Rule Learning and Using Classifying and Recognizing Patterns Making Decisions
2. a. Identify Terrain Features on a Map b. Determine the Elevation of a Point on the Ground Using a Map	Rule Learning and Using Identifying Objects and Symbols Classifying and Recognizing Patterns Visualization
3. Orient a Map to the Ground by Map-Terrain Association	Rule Learning and Using Classifying and Recognizing Patterns Spatial Relations Visualization
4. Determine Location on the Ground by Terrain Association	Rule Learning and Using Hypothesis Testing Spatial Relations Visualization
5. Locate an Unknown Point on a Map or on the Ground by Intersection or Resection	Rule Learning and Using Classifying and Recognizing Patterns Identifying Objects and Symbols Spatial Relations Visualization

Identify natural terrain features and determine elevation. This lesson is presented in three parts each of which uses live-action video with audio for the instruction. The first part, identifying the contour patterns for the eight natural terrain features, employs the same presentation design for each of the features. A definition is given during views of real terrain; explanation of the basic topographic pattern accompanies hand-drawn contour patterns; and description of the more complex patterns is given during views of a military map with specific identification of that feature. The second part, visualization and spatial orientation of the terrain features, employs a simple landform model for relating the two-dimensional contour patterns to a three-dimensional real world perspective. The third part, determining elevation, uses close-up views of military map sections and over-the-shoulder views to demonstrate the audio instruction.

Orient a map to ground by terrain association. The CAI uses live-action scenes of a soldier in the field performing the task of orienting the map using terrain association. Audio is used to describe the actions of the soldier. The practice and test use 360-degree pans of actual terrain and corresponding paper maps, keyed to the terrain, with the student's simulated location indicated on the map. The student pans the scene until a feature is centered on the screen which he can identify on the map. The student responds by indicating the direction from the marked location toward the feature. Direction is indicated by use of the light pen to mark one of the 16 labeled compass points of a graphic compass displayed on the screen.

Determine location on the ground by terrain association. This instruction also uses live-action scenes of a soldier performing the task of locating his position on the ground by terrain association. The practice and test use 360-degree pans and paper maps with three alternate locations marked. The student determines, by viewing the terrain displayed on the monitor, which location is his position (the camera position).

Locate an unknown point on a map or on the ground by intersection or resection. This is a two part lesson--one for intersection and one for resection. Both parts use live-action scenes of a soldier in the field performing the task. Audio describes the action taking place on the screen. The practice and test for each part require the student to answer questions about how the tasks are performed, what is the next step, and how the next step is done.

CAI COURSEWARE PRESENTATION ON MICROTICCIT

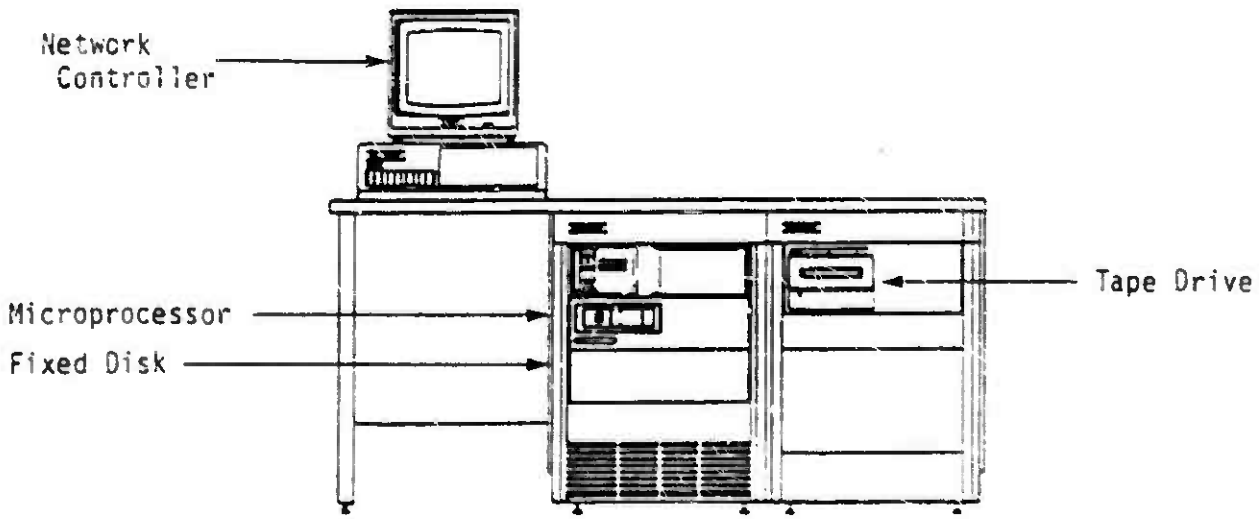
This section describes the hardware and software used in the development of the land navigation CAI and how the CAI is presented to the student.

The land navigation CAI courseware is developed on a Hazeltine Corporation System II MicroTICCIT system. The courseware is authored using ADAPT, a high-level programming language that runs on the TICCIT system, and a second authoring language APT, which is used in programming test management. Version 38.17 of ADAPT and APT is used.

The System II MicroTICCIT is designed to optimize ADAPT courseware development and delivery for medium-scale, computer-based training. The system used in this development had a Data General host configured to support eight MicroTICCIT workstations.

Data General host. The Data General host consists of:

- Data General's Eclipse S/20 microprocessor
- One 50 Megabyte hard (fixed) disk for storing programs and data
- A console or terminal (the Dasher model) which the TICCIT operator will use for communicating with the Data General System (not shown)
- A tape drive
- The MicroTICCIT Network Controller

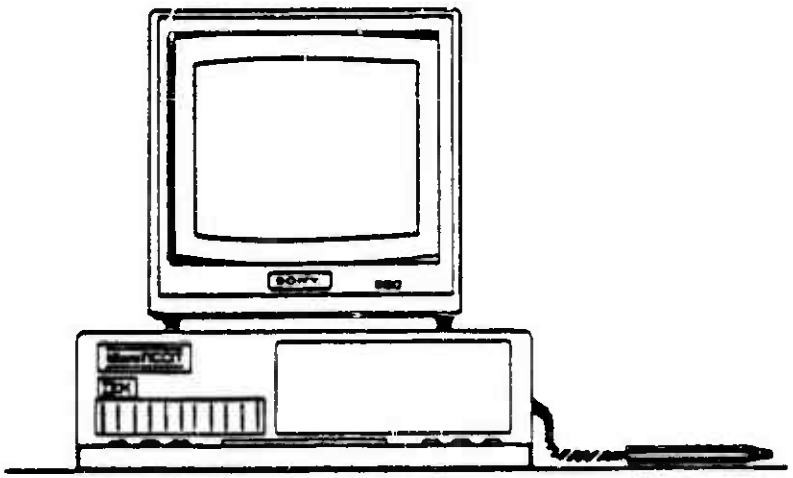


MicroTICCIT Workstation. The MicroTICCIT workstation consists of:

- an IBM-PC
- a Sony color monitor
- a light pen, and
- a Sony videodisc player.

The workstation is designed and configured to display TICCIT courseware. It can also be used as a terminal by TICCIT authors and operators.

One MicroTICCIT workstation is called the Network Controller. This workstation will be located near the Data General Host. The network controller controls the flow of information to and from the TICCIT system and each of the other MicroTICCIT workstations. It is used by the TICCIT operator to perform shutdown operations. Students and instructors can also use this workstation to access courseware.



The software included with the MicroTICCIT system are the Data General Real-time Disk Operating System (RDOS) and RDOS operating utility programs, the TICCIT operating system (MPOS) and MPOS utility programs, and the ADAPT and APT authoring languages.

HumRRO staff developed the land navigation CAI courseware on MicroTICCIT and integrated it into a land navigation (LN) course, Course 193. The CAI courseware is presented to the student through the use of light-pen-driven menus. Figure 1 outlines how the menus that follow are used in the control and presentation of the land navigation CAI courseware.

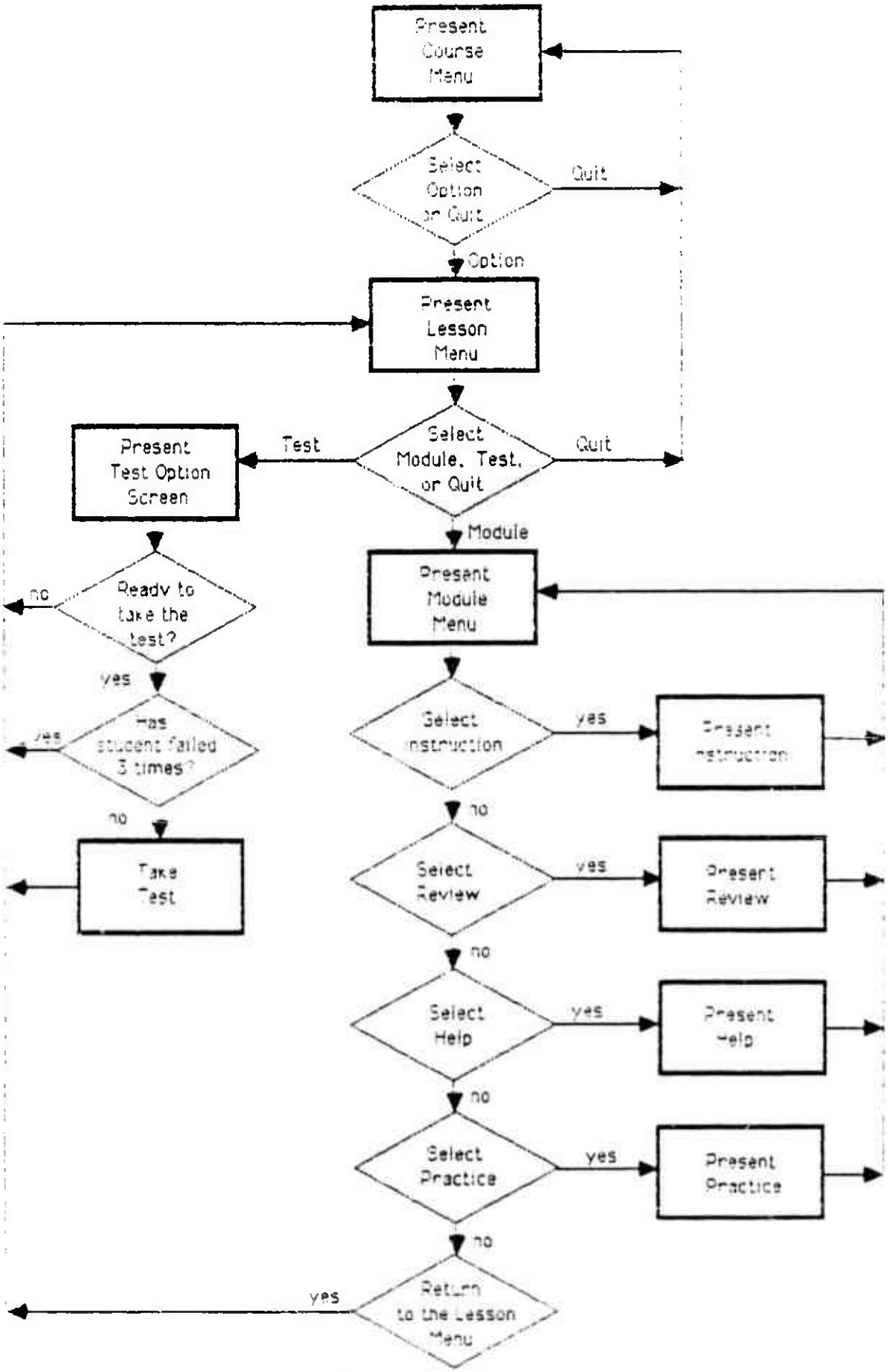
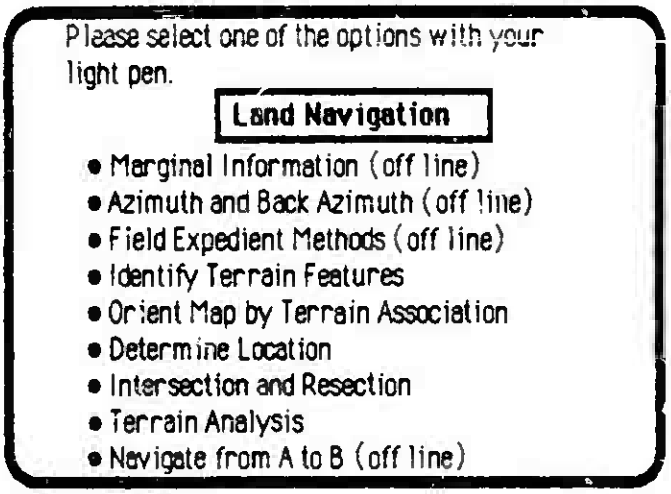
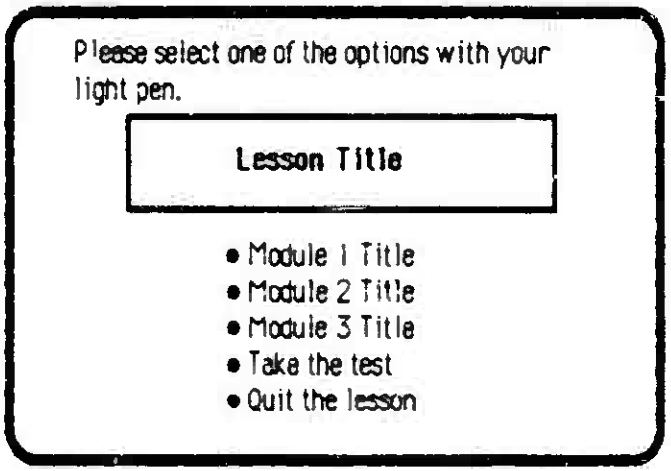


Figure 1 Flow Chart for Land Navigation CAI Courseware Menus

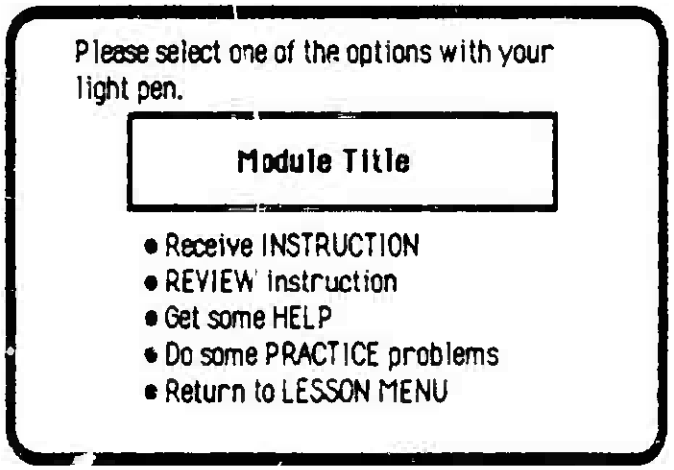
Course menu. When a student enters the LN Course, the first screen displayed is the main course menu, which lists all of the land navigation lessons.



Lesson menu. Lesson menus permit the student to move to the different parts or modules of the lesson. Here is a lesson menu for a three part lesson. The student may choose to see any or all parts of a lesson or to take the test.



Moduie Menu. The moduie menu is usually the standard instructional menu which permits the student to receive instruction on a topic, get a short review of the topic, get additional instructional help, do some practice problems, or return to the iesson menu.



Icons. An icon is a symbol that prompts a student to take a certain action. The most frequently used icons are:

Marking the BACK icon takes the student to the previously seen screen in that section or returns the student to a previous location. Marking MENU takes the student to the most appropriate higher level menu--usually the last one seen. Marking HELP branches the student to a help section tailored to helping the student on the part where help was requested; e.g., requesting help after missing a practice problem will help the student understand how to solve the problem just missed. Marking GO ON means to continue--proceeding to the next screen, next problem, or to the next section. All lesson icons are displayed in cyan, a light blue, indicating they are light-pen activated.

Test. Selecting a test takes the student to an intermediate display that asks the student if he is ready to take the test. The name of the selected test is shown. This display gives the student a chance to return to the menu if he is not ready to take the test. When the student goes beyond this point he is unable to quit until he completes the test. Selecting TEST branches the student to the test. A display, on the first page of the test

tells him if this is his first, second, or third attempt to pass the test.

Access to tests. Access to on-line tests is restricted and requires instructor or proctor intervention. When the student attempts to take the test, an advisor screen appears requesting proctor approval. If approval is given, an approval procedure is required. The proctor or instructor presses the ATT'N key on the keyboard and then the letter "P" (for proctor). The TAB key is used to move the cursor to the password area of the screen, the password is typed in, and the ENTER key is pressed. (The password can be obtained from the System Operator.) Another prompt, "Enter Proctor Function Desired," appears on the screen. The proctor then types "Y" for Yes and presses the ENTER key. This permits the student to access the restricted test. He can then proceed on his own.

A student may take a test three times. Each test has three parts. An introductory part tells the student how many questions there are in the test and how many must be answered correctly to get a GO. It also presents information concerning interactions with the system while taking the test, such as how to respond or enter responses.

The next part of the test contains the test questions. Some tests have more than one section of questions, with each section containing its own instructions. If a student starts a test he must finish all sections of it.

The third part contains feedback. The student is told how many answers were correct, the test criteria, and whether or not he got a GO or a NO GO. Also displayed is the number of test attempts remaining.

Each test has three versions so that a student attempting a test three times will see three different tests. The three versions are presented in the same order to all students. In some tests, however, items may be shuffled or reordered between trials and between students.

Using the light pen. The light pen is used by the student to access all of the instruction and the tests. The student makes no entries using the keyboard. However, the keyboard must be used by the proctor or instructor to log the student on and off and give students access to the tests.

Using the light pen, the student can move at a self determined pace through the lessons. There are few points where the student is "locked in" and unable to return to a menu. One exception is taking a test; the student is committed, once started, to finish the test. Some instructional sequences lock the student in where the author has determined the student should see the complete sequence. The student can, in most instances, move to the next lesson without completing all of the current lesson. Also, the student may choose to see any or all lesson

parts and whether to continue in a part from which an exit is permitted. This includes the practice problems. The student may quit any practice session. The student may choose to make a second or third attempt to pass a test. The menus always indicate which lesson parts the student has entered and whether a part was only entered or it was completed.

The meaning of TICCIT colors. Colors used in the CAI courseware have special meanings. Colors used to display menu options reflect the student's status in that lesson.

The use of cyan, a light blue, usually means that the area is light-pen activated--that is, touching that area with the light pen causes the computer to respond. Menu items normally appear in cyan until there is a change in the student's status. A menu option in cyan means the student has not entered either that lesson or one of its parts.

A menu item displayed in red indicates that a test was attempted and failed. When a menu item changes from cyan to red, it remains red until the student passes the test. Red also indicates wrong responses during practice problems.

When a student passes a test, the color of the task title on all menus changes from cyan or red to green. Students cannot select or enter a task's instruction from a menu when that menu shows the task title in green.

Yellow on a menu item indicates the student has started the activity but not completed it. Yellow is not used for tests; tests are marked with cyan, red, or green only.

When a menu item appears in black, the lesson or test cannot be accessed by the student. No response is given when the student attempts to access a black title.

A menu item in white indicates that a lesson or test must be completed off-line.

VIDEODISC

A two-sided videodisc was developed for use with the land navigation computer-assisted instruction. Side one of the videodisc is titled "NCO Land Navigation Skills" and side two is titled "Map Reading Skills". The production and post-production for the videodisc was done by Video Software Associates using HumRRO-produced shooting scripts, drawings, illustrations, and specially prepared materials. Mastering and videodisc copies were produced by Optical Recording Project/3M of St. Paul, Minnesota. The videcdisc contains a variety of video and audio material. It includes live-action scenes with descriptive audio, isolated stills of models and drawings, live-action scenes of models representing natural terrain features, 360-degree pans of terrain, and background video. It also includes audio for use with graphic and text presentations and dual-track audio for changing audio without changing the scene or while repeating a visual sequence. The contents of the two-sided videodisc are outlined in Table 4.

Table 3

Land Navigation Videodisc Contents

Disc Side #1: "NCO Land Navigation Skills"

Starting Frame No.	Topic
0	Disclaimer, etc.
110	Orient a Map [First track audio - sync] [Second track audio - no sync]
5954	Locating Position on a Map [First track audio - sync] [Second track audio - no sync]
12015	Intersection [First track audio - sync] [Second track audio - no sync]
22090	Resection [First track audio - sync]
26772	Summary [First track audio - sync] [Second track audio - no sync]
28896	31 Double Pans [no audio]
37904	Analyze Terrain [First track audio - sync] [Second track audio - no sync]

Disc Side #2: "Map Reading Skills"

Starting Frame No.	Topic
0	Disclaimer, etc.
100	Identify Terrain Features on a Map [First track audio - sync]
18490	Visualization of Terrain [First track audio - sync]
27543	Determine Elevation [First track audio - sync]
39841	31 Double Pans [no audio]

IMPLEMENTATION AND EVALUATION OF REMEDIAL CAI

The land navigation CAI was integrated into a TICCIT course, Course 193, and installed on the MicroTICCIT system located in the 19K BNCOC classroom training site at Ft. Knox, Kentucky. ARI and BNCOC personnel were trained in the use of the courseware. These ARI and BNCOC personnel did exercises with the land navigation courseware by registering as students in Course 193, the on-line 19K BNCOC land navigation course.

During the formative evaluation of the remedial CAI, a project staff member observed user reactions and interactions as they used the CAI and solicited user comments on courseware content and operation. The land navigation CAI was revised based on subject matter experts (the Steering Committee) evaluations.

DESCRIPTIONS OF COURSEWARE

This section describes the courseware for each of the five land navigation tasks. It states the lesson's objective and describes each lesson by menu item--instruction, review, help, practice, and test. (The land navigation courseware menus are presented in Appendix B.)

Identify Terrain Features and Determine Elevation

This lesson contains three modules which are available to the student when selected from the main menu. The lesson test option is also part of the lesson menu.

Learn to Recognize Terrain Features on a Map

There are two stated objectives in this module: (1) "You will be able to classify a designated point or area marked on a 1:50,000 military map into one of eight terrain categories," and (2) "You will be able to identify a designated terrain feature on a 1:50,000 military map." The eight natural terrain features are: Hill, Ridge, Saddle, Valley, Cliff, Draw, Spur, and Depression. After viewing the objective, the student sees the standard instructional menu.

When INSTRUCTION is selected from the menu, the student first sees a list of the eight terrain categories which are included in this lesson. This is followed by live-action video instruction with audio. The opening scene is of a soldier walking in a rural area and looking at a map. A narrator explains the importance of being able to identify natural terrain features. The description of each of the eight terrain features is as follows:

1. Live-action video views of the terrain feature with audio definition of the terrain feature.

2. Name of terrain feature in graphic overlay during the live action portion of the video.

3. Live-action video of soldiers hand drawing a simple contour representation of the terrain feature with audio description of the drawing.

4. Video view of a drawing of more complex contour representations of the terrain feature with audio description.

5. Video view of military map with a hand or pencil indicating the terrain representation with audio description.

The conclusion shows a soldier in the field looking at a map as the narrator poses a problem for him to determine the most direct and shortest route from one position to another. The video shows the soldier's hand pointing out his proposed route on a map as the audio describes his decision. The student is asked to try some practice exercises in identifying the eight terrain features.

When REVIEW is selected from the menu, the student views a summary portion of the instruction.

The instruction HELP section uses text pages and graphics to present the same teaching points on the eight terrain features. Additional information also is given to help the student understand the topographic patterns associated with each feature. Movement throughout this section is controlled by the student who, at any time, can choose to go back to any of the previously seen pages, go on to the next page, or return to the menu.

The introduction to the PRACTICE section explains that there are two types of exercises:

1. You will be shown a feature on a topographic map section, and you will use the light pen to mark the name of that feature (from a list of eight features).

2. You will be given a feature name and will use the light pen to mark that feature on a topographic map section.

There are eight practice problems in each exercise type.

In the first exercise type, a blinking open box (or boxes in the case of linear features), on the screen map section indicates the feature which the student is to select from a given list of the eight features. If the student's answer is correct, an overlay message congratulates him on his right answer, and he uses the light pen to advance to the next problem. If the student's answer is wrong, an overlay box appears which states the correct answer, and there is an automatic branch to play the video segment with audio definition of the correct feature. The same problem returns to the screen for the correct answer to be marked. The student must mark the correct answer before a branch to the next problem can occur.

In the second exercise type, a map section is shown on the screen with a message to use the light pen to mark the topographic pattern for a given specific feature. If the student's answer is correct, an overlay message congratulates him on his answer, and he uses the light pen to advance to the next problem. If the student's first attempt is wrong, an overlay message appears which gives a hint about what to look for in identifying the topographic pattern. The same problem returns to the screen for another attempt. A second wrong answer results in an overlay box that states a brief definition and in an

automatic branch to play the video segment of the map section examples with the correct feature.

The TEST for this module is included in the lesson test on Identify Terrain Features and Determine Elevation of a Point. The test is composed of two parts--the test on identifying terrain features is the first part. The questions on the test are presented in the same manner as in the practice exercises. However, there is no feedback for right or wrong responses. Complete instructions are given on how to interact with the system. There are 12 questions, six of each exercise type, on the part for identifying terrain features. The lesson test contains 18 questions, and the student must answer 14 correctly to pass. The last page informs the student of the number of correct responses made in each part of the test and states whether this constitutes a GO or NO GO. If the result is a NO GO, the student is told the number of test attempts that remain and which of the two parts, or both, needs review.

Learn to Visualize Terrain Features

There are two stated objectives in this module: (1) "Given a topographic map view of terrain, you will be able to identify the corresponding side view," and (2) "Given a side view of terrain, you will be able to identify the corresponding topographic map view." After viewing the objective, the student sees the standard instructional menu.

When INSTRUCTION is selected from the menu, the live-action video begins with a soldier in the field with a map. A narrator tells the student about the importance of being able to distinguish between features on a map. He states that one of the difficulties lies in the fact that a map is two dimensional, but the world we see is three dimensional. The view moves from an actual map to an overhead view of a landform model positioned to look flat. The narrator states that an understanding of the contour lines on a map can help to identify the terrain features. The soldier points to a terrain pattern on the map as the narrator says that the concentric circles tell us this is a hill. The soldier places an arrow on the map and the narrator hypothesizes how the hill would look if one were actually standing at that place. The soldier then pulls the hill off of the map and rotates the model to show the side view as it would be seen from the arrow position. This is followed by an explanation of how the contour lines indicate the size and shape of a feature. This procedure of first viewing a feature from the topographic perspective and then from a side position with an explanation of the contour lines, is repeated for all eight features. A representation of the relationship between the two dimensional map and the three dimential landform model is shown in Figure 2.

The last scene shows an arrow and the narrator asks the student to imagine what he'd see from that map position. He then

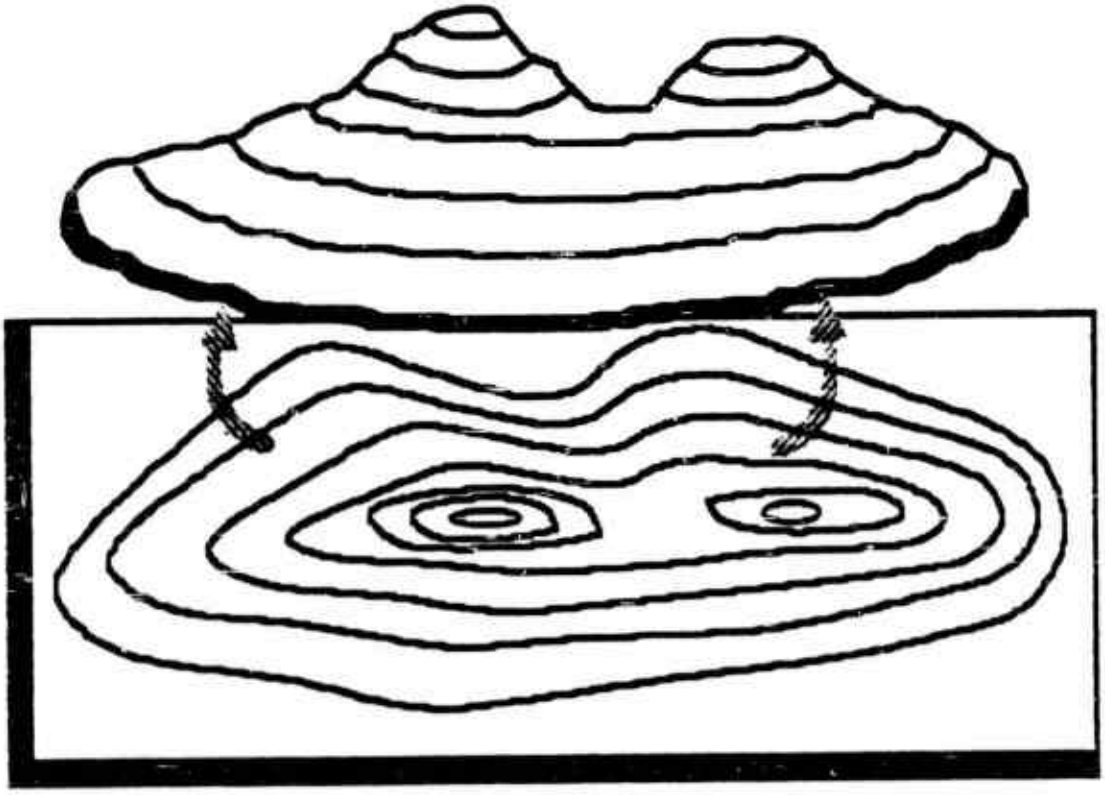


Figure 2. Landform model.

explains what one would expect to see in front, to the right, and to the left. Next, the model side view is shown and the explanation of what would be seen is repeated. The student is asked to try some practice problems in visualizing terrain features from different positions on the map.

When REVIEW is selected from the menu, the student sees a message which tells him that there is no review because the instruction is only about five minutes long. The student is encouraged to watch the instruction for the first time or as a review.

The instruction HELP section uses two text pages to present reminders to use the contour lines as indicators of size and shape and to note what one would expect to see in front, to the right, and to the left of a given position with each feature. The student can go back and forth between the pages or return to the menu.

The introduction to the PRACTICE section explains that there are two types of exercises:

1. An arrow will indicate your position on the topographic map board, and you will use the light pen to select the matching model side view.

2. You will be given a model side view and will use the light pen to select the correctly matching topographic position.

The are six practice problems in each exercise type.

In the first exercise type, the problem page shows an arrow on the topographic map board that indicates the position for which the student is to imagine he is standing and is to find the corresponding model side view. The student uses the light pen to move freely through six model side views or to return to the problem page. When he decides on a match, he marks the icon, "This is it." If the student's answer is correct, an overlay message congratulates him on his right answer, and he uses the light pen to advance to the next problem. If the student's first answer attempt is wrong, an overlay message appears that provides a hint about what to look for in front, to the right, and to the left of the arrow's position. The student returns to the same problem for another attempt. A second wrong answer results in the appearance of an overlay message which states that the answer was incorrect, gives the number of the correct model side view, and tells the student to return to the problem. The correct side view must be marked before a branch to the next problem can occur.

In the second exercise type, the problem page shows a model side view for which the student is to select the corresponding topographic view. On the answer page, numbered arrows are shown at three locations on the topographic map board. The student

uses the light pen to mark one of the arrows as his answer. If the student's answer is correct, an overlay message congratulates him on his right answer, and he uses the light pen to advance to the next problem. Of the two incorrect responses, one is completely wrong and the other is a near-miss. If the student's first answer attempt is the completely wrong one, an overlay message simply states that the answer is incorrect, and the student is to return to the same problem for another attempt. If the second attempt is the completely wrong answer, the overlay message states that the answer is incorrect, gives the number of the correct arrow, and tells the student to return to the problem and mark that correct answer before advancing to the next problem. If the student's first or second answer attempt is the near-miss, an overlay message gives a hint about the arrangement of features from the given position, and the student is to return to the same problem for another attempt.

There is no TEST for this module included in the lesson test on Identify Terrain Features and Determine Elevation of a Point. Learning to visualize terrain features on a map does not correspond to any existing Army task, and hence, has no standard for testing. The visualization module was included as a helpful (and possibly, missing) link between identifying terrain contour patterns on a map and visualizing the actual terrain represented by the contour patterns.

Determine the Elevation of a Point on a Map

The objective of this module is: "Upon completion of this part of the lesson you will be able to determine the elevation of any point on a standard military map to within half a contour interval". After viewing the objective the student sees the standard instructional menu.

The INSTRUCTION is presented in live-action video with audio. The instruction starts with a scene of a soldier in the field viewing the terrain. The audio, in voice-over, describes what the soldier is viewing and sets the stage for the following instruction. The remainder of the instruction used live-action, close-up views of map sections and over-the-shoulder views of the soldier pointing and demonstrating the teaching points presented by audio. The instruction ends with a segment which summarizes the procedures for determining elevation.

When the student selects REVIEW he views the live-action summary which was a part of the instruction.

The instruction HELP section presents the same teaching points covered in the instruction section. This time it is presented in a different format with text and graphics used to present the instruction. The student can move through the help section at his own pace. At any time, the student can choose to

go back to the previous page, go on to the next page, or return to the menu.

The PRACTICE begins with an introductory section which informs the student as to what he will see and how to interact with the system. He is told that he will see map sections on the screen and will be asked to determine the elevation of points on the map. The student enters the determined elevation through use of a number pad which is displayed on the screen along with the question and the map section. When the student touches a number on the number pad the number touched appears in a register at the top of the number pad. The numbers are 0-9. A maximum of four numbers can be displayed in the register--enough to record any of the answers. The numbers appear in the register in the order in which they are touched on the number pad. The number pad has a "C" for use in clearing the register and an "E" for entering the student's response. There is also a "CI" for contour interval. When the student touches the CI a picture of the contour interval note from the map being used in the current problem is displayed on the screen. After four seconds the student is automatically returned to the same problem page.

When the student has entered the determined elevation he touches the E to enter the response. If the elevation is correct, an overlay message congratulates him on his right answer. If the elevation entered is incorrect, the student receives a wrong answer graphic display on the screen along with icons which permit the student to go back and retry the problem, get help, or to return to the menu. Selecting help causes a text display to appear on the screen which gives step-by-step guidance on how to determine the elevation. The text is superimposed on the map section so the problem, the map, and the guidance are all visible. The student is then returned to the same problem for retry.

There are 16 practice problems using map sections from three different maps with three different contour intervals. Although all new maps being published are in meters there are many maps in use which are in feet. Therefore, both feet and meters are used in the practice exercises. One of the first things a person should do when determining elevation is to check the contour interval. The problems presented in the practice are much harder if the student does not check the contour interval. The questions ask the student to determine the elevation of features represented on the map such as road and stream intersections, hilltops, saddles, etc. When the target feature is not obvious or there is more than one feature of the same description, arrows were added to the screen to indicate the specific feature.

The TEST for this module is a part of the lesson test on Identify Terrain Features and Determine Elevation. The test is in two parts--the test on elevation is the second part. The questions on the test are presented in the same manner as the practice problems. However, there is no feedback for right or wrong answers after each question. There are six questions on

the test for determining elevation. The lesson test contains 18 questions and the student must answer 14 correct to pass.

Orient a Map by Terrain Association

The purpose of this lesson is to teach the student how to determine the direction to key terrain features by comparing the terrain features on the map to the visible terrain. The lesson goal differs somewhat from the goal of the corresponding task performed in the field. In the operational task, a map is placed on the ground so that the directions on the map correspond to the actual directions. Since coordinated movement of map and terrain is not economically feasible on a single-monitor, single-videodisc system, the response was modified to one that was compatible with system constraints. Standards were unchanged; that is, responses were required to be within 30 degrees ($\pm$ 15 degrees) of the correct direction.

From the lesson menu the student can choose to get instruction, take the lesson test, or quit the lesson. Choosing instruction takes the student to the standard instructional menu.

The INSTRUCTION is presented in live-action video. It begins with a soldier in the field with a map. The soldier studies his map, looks for prominent terrain features that can be found on the map, and demonstrates the procedure of aligning the features on the map to the terrain features he is viewing. Two voices are used--one describing what is being done or is to be done, the second simulating the thought processes of the soldier as he performs the task. The instruction uses over-the-shoulder shots, close-up views of the soldier pointing to map features, zooms and pans.

The REVIEW is presented in text with audio. The text lists the three steps in orienting the map. As the audio reviews the listed steps, the part being discussed changes from black text to yellow and then to white when the audio for that part is finished.

Instruction HELP informs the student who is having trouble identifying terrain features to review the lesson on Identifying Terrain Features, accessed by returning to the menu. The student is reminded to turn the videodisc over to view that material.

In PRACTICE the student tries problems using terrain association to orient the map. The problems use scenes viewed on the screen and a booklet of maps prepared especially for this task. An introduction explains what will be seen and how to interact with the system. A demonstration is given of a 360-degree pan, and an answer display of a compass with the 16 compass points labeled is shown. Answers are recorded by touching a compass point label with the light pen. Next the graphic "control panel" display is shown which is used to control the pans. The control panel is shown as Figure 3. There are two

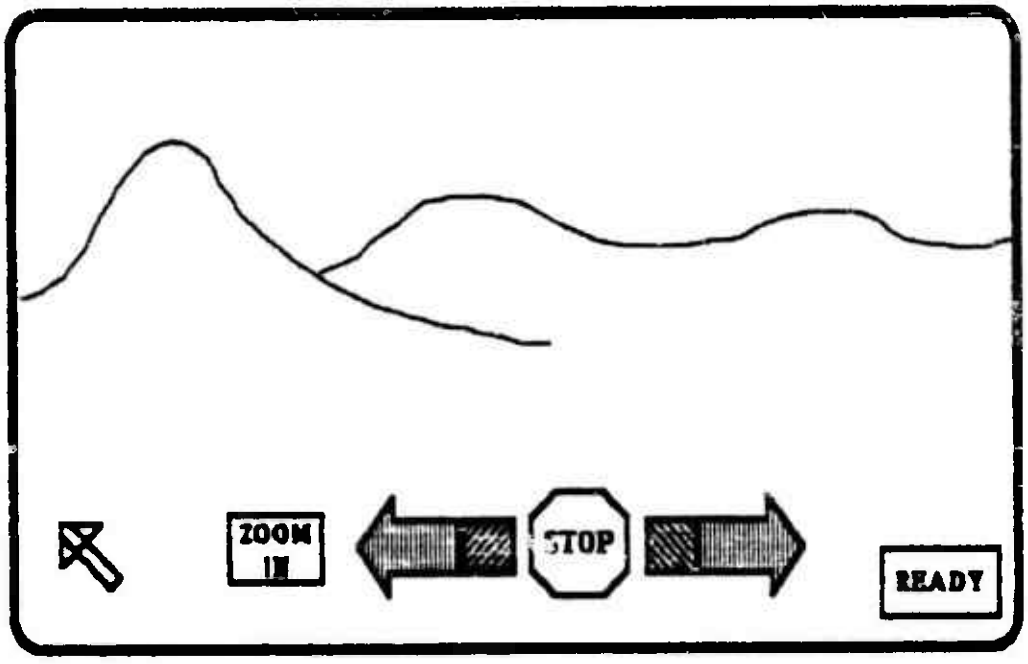


Figure 3. Control panel used to control pans.

arrows, left and right, each with areas in two colors. Touching the green part of the arrow causes a fast pan in the direction of the arrow, and touching the yellow area of the arrow causes a slow pan. In the center is a graphic of a traditional highway "STOP" sign. Touching Stop will always cause the pan to stop. Each time Stop is touched another graphic arrow, this time in black, will move to show the student how far he has panned. This arrow does not show compass direction. It shows how far the student has panned from the beginning of the pan. The control panel also has an area labeled "ZOOM IN". Touching this area causes a close-up view of the terrain, simulating the use of binoculars. The student may pan while zoomed in or zoomed out. The student may go back to a previous page, go on to the next page , or return to the menu from any of these introductory pages.

Each pan covers 360 degrees in 3-degree increments. One pan was photographed with a normal lens and the other with a telephoto lens.

Next the student uses the light pen to participate in an on-line demonstration on using all the features of the control panel and to practice entering answers.

The practice has eight problems. Five of the problems use civilian maps and three use military maps. In the exercises the student pans the scene to find terrain features which he can also identify on the map. When he thinks he knows the relationship between the map and the terrain, he pans the scene until one of the identified features is in the middle of the screen. The student then turns his map so he is looking from his own simulated position toward that same feature on the map. When the student has correctly oriented the map he determines the direction of the feature displayed on the monitor from his simulated position. When he thinks he knows the direction, he touches an icon labeled "READY". At this time the control panel is replaced with the graphic of the answer display and a text display: "What direction are you looking now (mark the compass with your light pen)?" If the student is correct, an overlay message congratulates him on his right answer. If the student is incorrect, a hint is overlaid on the screen with the scene. Touching GO ON takes the student back to retry the problem. If the student is incorrect a second time the student receives a wrong answer display and gets the opportunity to go-on to the next problem or to return to the menu.

The TEST is presented in the same manner as the practice. Since a student may choose to take the test first, before seeing the instruction, full instructions are available at the beginning of the test. The student is provided the opportunity to skip the instructional material on any or all of the three tries they have to pass the test. There are 6 test items. The student must get four correct to pass.

Determine a Location on the Ground by Terrain Association

When the student selects this lesson the first thing he sees is the lesson menu which lets him choose to get instruction, take the test, or to quit the lesson.

The instruction begins with a statement of the lesson objective. The objective states that when the student completes this lesson he will be able to select his location on a map from three choices by comparing the map with the terrain he can see. The task as trained is somewhat simpler than the operational task in which the soldier must actually determine the grid coordinates of his location. Though technically feasible, the operational task was judged to be too difficult given the limited field of view of the display. The next thing the student sees is the standard instructional menu.

The INSTRUCTION is presented in live-action video with voice-over. A soldier is shown in the field with a map. The soldier first demonstrates the procedure for orienting the map--the first step in determining location. After he orients the map he continues to perform the task by relating the key terrain features, the foreground terrain and the terrain he is standing on to determine his map location. The live-action scenes use pans, zooms, over-the-shoulder and close-up shots of the action. Two voices are used; one describes the action being taken by the soldier and the other simulates the thoughts of the soldier as he goes about performing the task.

The REVIEW is presented in text form with audio. A text page lists the two major steps to determining location--orient your map and determine your location. It also lists the three steps used to perform each of the major steps. Audio is used to discuss each step. As a step is discussed the text changes from black to white, and back to black at the end of the discussion for that step. The title and two major steps are shown in yellow.

The HELP section is a text page. The text informs the student that if he does not understand how to orient a map, he can receive instruction on how to do it by touching the appropriate label at the bottom of the screen. If he chooses to see the instruction, he sees the live-action video instruction on how to do that task. Otherwise, he is directed to return to the menu.

In the PRACTICE problems the student practices using terrain association to find his location on maps. Terrain scenes are shown on the screen. Maps with three locations marked are provided in a booklet of maps. The student may choose to skip the instruction on how to use the control panel which is shown in graphic form over the scenes on the screen and is used to pan the 360-degree scene and to enter answers. (A full description of the control panel is described in the instruction section of the lesson on Orient a Map using Terrain Association.)

The student is instructed to look in the map booklet, find map 1, and find the locations labeled "A", "B" or "C". The object of the exercises is to view the terrain in the 360-degree pans and determine whether the pictures were taken from position A, position B, or position C. When the student decides he knows which position the pictures were taken from he uses the light pen to mark the appropriate A, B or C labeled area on the right of the screen.

There are eight practice problems. Five of the problems use civilian maps and three use military maps. The student is informed that since all the test items use military maps, he should practice the last three problems in the exercise more thoroughly.

If the student is incorrect on the first try, a graphic display appears at the bottom of the screen informing the student that the answer is wrong. At the same time, the scene pans to a prominent or key terrain feature and text presents hints as to what to look for in the scene and on the map. Example- "Here's a hint. Notice this large hill to your left (direction arrow is pointing to the left). Also look at the road to your right, and the hill that rises behind you to the right." If the student is wrong on the second try, he also gets the wrong answer display. With the wrong answer display is feedback indicating the correct answer and icons permitting him to go to the next problem or to return to the menu.

The TEST has six questions. A student must answer four correctly to pass. As with the practice, the student has a chance to skip the on-line instruction on use of the control panel. The test questions are presented in the same manner as those in the practice. The major difference is that when the student touches an A, B or C, the control panel is replaced with a display which tells the student which answer they marked and asks them to verify that response by use of icons labeled yes and no. If they touch no, they return to the problem with an opportunity to enter a different choice. If yes, the response is evaluated and the next problem is presented.

Locate an Unknown Point on the Ground by Intersection or Resection

The lesson menu permits the student to choose to see instruction on intersection, see instruction on resection, to take the lesson test which covers both intersection and resection, or to quit the lesson. Simulation of the procedures involved in intersection and resection was not possible given technical constraints. Consequently, the instruction concentrated on the procedural knowledge involved in the task. The practice and test problems used the state of the map as a cue to identify the next step in the procedure. The state of the map is how the map looks when a question is presented, e.g., are there any lines drawn or any locations marked?

Intersection

When the student chooses to see instruction on INTERSECTION he is first presented with the objective. The objective states that, when the lesson is completed, the student will know the steps that must be performed to determine a location by intersection without the use of a compass. Next, the student sees a standard instructional menu.

When the student selects INSTRUCTION he is asked to find the map in the map booklet labeled INTERSECTION--INSTRUCTION so he can follow along with the instruction on the map.

The instruction is presented in live-action video with audio. Two voices are used. One, a voice-of-authority, describes the actions of the soldier in the field as he goes about performing the task of locating a position by intersection. The other voice simulates the thoughts of the soldier as he goes about doing the task. The action uses pans, zooms, close-ups, and over-the-shoulder shots. The soldier demonstrates orienting the map, locating his position on the map, sighting along a straightedge from his position toward the target feature, and drawing the grid azimuth. He then moves to a second location from which the same target feature can be seen. Again, he orients the map, locates his position, sights along the straightedge from his position toward the target feature, and draws the grid azimuth using the straightedge to guide the pencil. He then shows that the target position is located at the point where the two lines "intersect".

The REVIEW is a short version of the live-action demonstration from the instruction section. Here the highlights of the procedure are covered. As each step is discussed, that step is presented in a line of text at the bottom of the screen. The text changes to match the audio presentation.

The HELP section is a text page. It reads--"You may review related lessons by selecting a topic on the menu below. If you need help in identifying terrain features, go to Lesson 4 on the course menu. If you are still having trouble, review the instructions for this lesson." The two instructional pieces available through this menu are the review for Orienting a Map Using Map-Terrain Association and the review for Determine Location Using Terrain Association. If either of these is selected, the student views the selected review and then returns to this menu. When finished, the student returns to the instructional menu.

In PRACTICE the student is presented with a series of still pictures of close-up shots of a map and a series of two-part questions. The maps show the progression of steps (locations and lines drawn on the map) for the task. The student is told at which position he is located and asked to indicate what the next step in the procedure would be. Here is an example of a question

which appears with a photo showing the soldier's position marked with an "X" and a grid azimuth drawn toward the target feature:

What is the next step (you are at location 1)?

A. Find the grid coordinate of the point.
B. Find the azimuth to a terrain feature.
C. Go to a second location.
D. You're done. There's no more to do.

Here the correct answer would be C. Any other selection gets a text overlay with helpful hints and instructional feedback, and a chance to retry the question. A second incorrect response gets the student a wrong answer display, what the correct answer is, and icons which permit the student to go to the next part of the question or return to the menu. A correct answer gets a right answer display and a chance to go to the next part.

Here is the second part of the question:

Part 2: What's a good location to go to?
A. It should be closer to the unknown point.
B. You should be able to see the same object.
C. You should walk toward the object.
D. It should be on higher ground.

The correct answer is B. System response to student input is the same for part two as for part one.

There are six practice problems, each with two parts. In part one the student determines what the next step is by looking at the situation displayed on the map. In the second part the student must say something (select from alternatives) about how the step is performed.

Resection

When the student selects to see the instruction on RESECTION he is presented with the module objective--"When you have completed this lesson, you will know the steps involved in determining your location using resection." Next comes the standard instructional menu.

In INSTRUCTION the student is first asked to look in the map booklet and find the map labeled RESECTION--INSTRUCTION so he can follow along with the instruction on the map. When this is done and he chooses to continue, he sees a live-action demonstration, in the field, of a soldier performing the task. Here again, there are two voices. One voice describes the action and the other simulating the thoughts of the soldier as he goes about performing the task. There are pans, zooms, close-ups, and over-the-shoulder shots of the soldier doing what is being described in audio. The soldier demonstrates orienting the map,

locating a target terrain feature on the map that can also be seen in the terrain, sighting along a straightedge past the map terrain feature toward the target terrain feature, and drawing a line on the map from the map terrain feature location toward himself. Then, without moving the map, the soldier identifies another feature which can also be found on the map. Again the soldier sights along the straightedge past the new map terrain feature and the corresponding target terrain feature in the scene, and draws a line along the straightedge from the map terrain feature toward himself. The soldier then indicates that his location, on the map, is the point where the two lines cross.

At the end of the instruction the student returns to the menu. The instructional video can be seen as many times as desired.

The REVIEW is a presentation of excerpts from the instructional live-action video which present the key points of the instruction.

The HELP section is presented in text form. It informs the student that he may review related lessons by selecting a topic from the menu items listed at the bottom of the page. The menu permits the student to see a review of Orient a Map Using Map-Terrain Association or a review of Determine Location Using Terrain Association. It also states that if he needs help with identifying terrain features, he should go to Lesson 4 on the course menu for instruction or review on that subject. If either of the menu topics is selected, the student views the selected review topic and then returns to this menu. When finished, the student returns to the instructional menu.

In PRACTICE the student sees still pictures of a map that is being used to locate a position by resection without a compass. Questions and response alternatives are presented in text form along with the video still on the screen. Each question is presented in two parts. In the first part, the student determines what the next step is by looking at the picture on the screen. In part two, the student must say something (select from alternatives) about how that step is performed. Here is an example of one of the two-part questions. The student has progressed to the point where the map has been oriented. The view on the screen shows a hand and a straightedge on the map (no lines have been drawn on the map).

Part 1: What do you do next?

A. Find the azimuth to a terrain feature.
B. Find the azimuth to an unknown object.
C. Find the grid coordinates of your position.
D. Orient your map to the terrain.

Part 2: How do you find the azimuth?

A. Look at prominent terrain features.

B. Rotate your map until it is oriented.
C. Sight along a straightedge from behind the map.
D. Use a protractor to measure the azimuth.

If the student is wrong on the first try he gets a helpful hint and returns to retry the question. If incorrect a second time, he gets a wrong answer display, is told what the answer is, and then proceeds to the next part or next question. There are four practice problems.

Test

The lesson TEST has two parts. The first part covers intersection--the second part covers resection. The student must pass both parts to pass the test. Test items are presented in the same manner as the practice problems. There are six test questions on intersection and the student must answer five correctly to pass that part. Resection has four questions, and the student must answer three of the four questions correctly to pass this part.

Analyze Terrain Using the Five Military Aspects of Terrain

The purpose of this lesson is to teach the student how to analyze and rate each of the five military aspects of terrain, in a given photographic situation, as favorable or unfavorable.

The lesson is presented to the student using a lesson menu listing an introduction module, five instructional modules--one instructional module for each of the five military aspects of terrain--take the test, and quit the lesson.

When the student selects to see the INTRODUCTION he sees the title of the lesson and the lesson objective in text form. The remainder of the introduction is presented using text with audio. Lists are presented in stepped sequences highlighting the text which coincides with the audio being presented.

This module presents the acronym "OCOKA" and its relationship to the five military aspect of terrain and the meaning of each of aspects. Once started, the student cannot exit from the introduction.

In the last part of the introduction the student is required to use the light pen to arrange the five military aspects of terrain in the correct order to match OCOKA. When the student determines the listing is in the proper order he touches "This is it" to have the response evaluated. All out of order aspects are presented in red and the student must retry the exercise. When all aspects are correctly positioned, the listing is indicated in green with a congratulatory graphic display. At this time the student may return to the lesson menu for his next solution.

The INSTRUCTION section for each module uses color drawings and audio from the videodisc to demonstrate and explain the meaning and application of one military aspect of terrain analysis. The color drawings were made using the line drawings from existing military training as a reference. The student steps through a series of drawings with audio and graphic displays which emphasize teaching points. For the fifth aspect, avenue of approach, the instruction emphasizes use of the analysis for the other four aspects in the evaluation for avenue of approach and adds instruction on two additional considerations--adequate maneuver space and ease of movement.

The REVIEW section is a short version of the instruction presented in the same manner as the instruction section.

The HELP section uses a series of text pages to present the meaning and application of the applicable military aspect of terrain analysis. The student steps through the text pages using the light pen.

In PRACTICE the student views color drawings of battle scenes. Questions are presented using audio, text and graphics. The student responds by using the light pen to indicate whether a military aspect of terrain analysis, as presented in the depicted situation, would be an advantage or disadvantage. Some questions are entirely textured. The number of practice questions varies from four to twelve for each module.

If the student is incorrect, a wrong answer graphic display is presented along with icons which permit the student to go back and retry the problem, quit the practice by returning to the menu, or to obtain help. If help is selected the system presents a text overlay on the screen describing the correct answer and the reason for the correct answer. The student then has an opportunity to retry the problem. If the student is correct, a graphic right answer display is shown with a "GO ON" icon to take him to the next problem.

The TEST is a lesson test and covers all five aspects. There are no tests at the module level. The first part of the test involves using the light pen to arrange the five listed aspects of terrain analysis in the correct order to match OCOKA. When the student touches an aspect on the screen with the light pen, that aspect moves up in the listing (the one touched exchanges places with the one above). In the next part the light pen is used to arrange the meanings of the five aspects so that the correct meaning is opposite the appropriate aspect. Next the student is presented with color drawings of two battle situations. Audio is used to describe the situation depicted in the drawings. Text with audio is used to ask the student to analyze the depicted terrain in the stated condition for one aspect and indicate whether it would be to an advantage or disadvantage. In the case of the fifth aspect, avenue of aporoach, the student indicates whether the presented avenue of

approach is good or bad. There are twenty test questions and the student must answer sixteen questions correctly to pass the test.

REFERENCES

Blade, M. G., & Watson, W.S. (1955). Increase in spatial visualization test scores during engineering study. Psychological monographs: General and Applied, 69(12), 1-13.

Blatter, P. (1983). Training in spatial ability: A test of Sherman's hypothesis. Perceptual and Motor Skills, 57(3), 987-992.

Cohen, M. E. (1980). The effects of environmental interactions on the structure and process of cognitive mapping. Unpublished doctorial dissertation, Temple University, Philadelphia.

Goldin, S. and Thorndyke, P. (1981). Spatial learning and reasoning skill. Santa Monica, CA: The Rand Corporation, R.-2085-ARMY.

Knerr, C. M., Sticha, P. J., Elder, B. L., Ramsberger, P. F., Harris, C. D. & Tkacz, S. (1984). Interactive videodisc training for Army land-navigation skills. Alexandria, VA: Human Resources Research Organization.

Levine, J. M., Schulman, D., Brahlek, R. E., & Fleishman, E. A. (1980). Trainability of abilities: Training and transfer of spatial visualization (Contract No. N00014-77-C-0268). Princeton, NJ: Advanced Research Resources Organization.

Marshall, S. L. A. (1979) Bringing Up the Rear (Cate Marshall, Ed.). San Rafad, CA: Presido Press.

Ramsberger, P. F., Hopwood, D., Hargan, C. S. & Underhill, W. G. (1983). Evaluation of a spatial data management system for basic skills education: Final phase I report (HumRRO Final Report FR-PRD-83-23). Alexandria, VA: Human Resources Research Organization.

Ramsberger, P. F., Sticha, P. J., Knerr, C. M., Elder, B. L., Rosenblatt, R. D., Paris, J., Wagner, H., & Leopold, A. S. (1984). Evaluation of a spatial data management system for basic skills education: Phase II. (HumRRO Final Report FR-TRD(VA-84-2). Alexandria, VA: Human Resources Research Organization.

Simutis, Z. M., and Barsam, H. (1983). Terrain visualization and map readings. In H. L. Pick & L. P. Acredo (Eds.), Spatial orientation: Theory, research, and application. New York: Plenum Press.

Tkacz, S., Paulson, D., Hirsch, J., and Morris, M. (1986). Spatial cognition: Improving map interpretation and terrain association. Paper presented at Eastern Psychological Association meeting, New York.

U.S. Army. (1982). A systems approach to training (TRADOC Reg 350-7). Ft. Monroe, VA: U.S. Army Training and Doctrine Command.

U.S. Army. (1975). Interservice procedures for instructional systems development (TRADOC Pam 350-30). U.S. Army Training and Doctrine Command.

GLOSSARY

ADAPT	The MicroTICCIT courseware authoring language.
APT	A MicroTICCIT courseware authoring language largely replaced by ADAPT but still used for creating course maps and test-control files.
ATT'N key	A keyboard function key that must be pressed to LOG ON, LOG OFF, or access other Attention Functions.
CAI	Computer-assisted instruction; refers to instructional materials delivered on a computer; also called courseware.
CBI	Computer-based instruction; refers to instructional materials delivered on a computer; also called CAI or courseware.
CMI	Computer-managed instruction; refers to programs used to collect and report performance data from students using computer instruction.
Computer Terminal	A display screen and keyboard or other input device (such as a light pen) that lets one communicate with a computer.
Course 193	The 19K BNCOC MicroTICCIT Land Navigation course that includes courseware, menus, and tests.
Courseware	Refers to instructional materials designed for delivery on a computer.
Cursor	The character on the computer screen that indicates where text that is entered from the keyboard will appear. The TICCIT cursor looks like a set of brackets: [].
Hardware	Refers to computer equipment such as a hard disk, the printer, terminals, videodisc, videodisc player, etc.
Icon	A symbol on the computer screen that prompts the user to take some action.
Light Pen	An input device used at the terminal that allows the user to touch an area on the screen to respond to prompts. This is an alternative to using the keyboard.

Logging off	The process for exiting from the computer. Logging off lets the computer know a particular user is now off-line.
Logging on	The process of entering the computer to use a program. It involves typing in an identification number and a course number.
Menu	A list of options on the computer screen that branches the user to specified routines or course locations.
MicroTICCIT	The term applied to Ticcit system configurations. The MicroTICCIT System II has a host station comprised of a Data General S/20 microprocessor 50 megabyte hard (fixed) disk and console, network controls, and workstations.
MicroTICCIT Workstation	A computer terminal, consisting of an IBM PC and a Sony display screen, used to interface with the operating system and courseware. Optional equipment includes a light pen and a Sony videodisc player.
Network Controller	The MicroTICCIT terminal that controls the flow of information to and from the TICCIT system and each of the other MicroTICCIT workstations.
Off-line	Refers to material that is not on the computer system. This material cannot be accessed through the computer.
On-line	Refers to material that can be viewed or accessed through the computer.
Proctor Password	A word used to access TICCIT's proctor functions.
Prompt	Any word or symbol on the computer screen that suggests that the user should enter information or take some action.
RDOS	An abbreviation for Real-time Disc Operating System. It is the Data General multi-user operating system.
Restricted Test	A TICCIT test that cannot be accessed by a user without use of the proctor password.
Software	Computer programs.
TICCIT	The MicroTICCIT operating system.
TICCIT Operator	A user who is authorized to operate the MicroTICCIT system and performs registration, courseware transfer, etc.

TICCIT Proctor	An instructor who has some training in the use of the TICCIT system and manages instruction in the TICCIT classroom.
User ID	A unique number assigned to a user during registration and used when logging-on.
Utility Program	A program designed to perform a function, such as run a Student Progress Report, other than running courseware.

APPENDIX A

Implementation of HumRRO Adapted TECEP Learning Guidelines

General learning guidelines

An analysis of the TECEP Learning Guidelines revealed certain training specifications that were common across TECEP categories. These common specifications were combined into the following set, labeled General Learning Guidelines:

1. Specify learning objectives
2. Relate learning to a job
3. Provide for self-paced training
4. Provide visual aids and mnemonics
5. Provide rewards
6. Provide knowledge of results
7. Provide practice

The following paragraphs explain, under the heading of each guideline, how the training designs of the land navigation tasks met these general training requirements.

Specify Learning Objectives. Each task (lesson) contained a TICCIT text page on which was given the lesson objective and the objective(s) of any required segment(s). These objectives were taken from the Soldier's Manual of Common Tasks. The beginning of the instruction, whether presented by video or TICCIT pages and graphics, described the task to be learned.

Relate Learning to Job. The instruction for each task was based on information gathered from Army field and technical manuals. The setting, whether shown by video or TICCIT graphics, was in a military context. Props for the instruction, examples, practice, and tests were photographic representations of actual terrain and maps, realistic models, or realistic graphic depictions.

Provide for Self-Paced Training. The interactive networking for the CAI assures self-paced training. No two soldiers will take the same amount of time to complete a lesson; nor will their progress through a lesson necessarily take the same form. Each lesson allowed ease of movement between and within the various subparts. The lesson menu provided a choice of any available part of the lesson or the option to quit the lesson. TICCIT pages have available forward and backward movement and return to the menu.

During videodisc instruction, movement by the student is limited. There are two reasons for this: (1) videodisc

instruction is considered a unit of information which is best seen in its entirety; and (2) the system cannot determine on which frame the videodisc is stopped, which makes it difficult to allow random stops or backing up.

The test component of each lesson is completely restricted. Once the soldier has selected the test from the menu, the test must be completed. Until the test is completed, the soldier can not move to another part or quit the lesson. Failure to complete a sufficient number of test items will result in a "NO GO" for that test attempt.

Provide Visual Aids and Mnemonics. This guideline suggests nine aids to help relate the material to the learning task: diagrams, pictures, charts, graphs, rhymes, acronyms, key words, common associations, and mnemonics. For each task, only a subset of the nine aids is appropriate for use. A preliminary review of the land navigation tasks indicated that all five could benefit from the use of pictures, key words, common associations, and mnemonics.

Provide Rewards. The first opportunity for soldier response is followed by feedback. If the response is correct, then the feedback serves as a reward (positive reinforcement). The practice items were ordered from simple (easier) to more complex (harder), which should maximize the likelihood of early positive rewards. Of course, the possibility existed for an incorrect response which would be followed by error feedback. However, this feedback provides guidance for arriving at the correct response, and the soldier has other attempts at correctly answering the same item.

The total number of items in a practice set, the ease of movement allowed within a lesson, and the help available to those having difficulty combined to provide the opportunity for slower learners to receive as many or more positive rewards for correct answers as the faster learners.

Provide Knowledge of Results. During the practice portion of the lesson the soldier received immediate feedback to each response via a TICCIT page or overlay. A correct response elicited a congratulatory message. An incorrect response received guiding feedback, which was item-specific and based on error analysis. This feedback pointed out the probable error, explained the correct procedure, and gave the correct answer. In the task test, each response generated a simple feedback statement that indicated either a correct or incorrect answer.

Provide Practice. Both the total number and the scope of items in the practice set of each task were comparable to that of the test for each task. This allowed the soldier to practice to the level of performance stipulated in the standard of each task.

Overlearning could not be guaranteed. The design of the instruction, examples, and practice should encourage the soldier

to remain with a part through its entirety. However, the ease of movement that was provided within a lesson allowed the soldier to select the test before practicing beyond simple mastery.

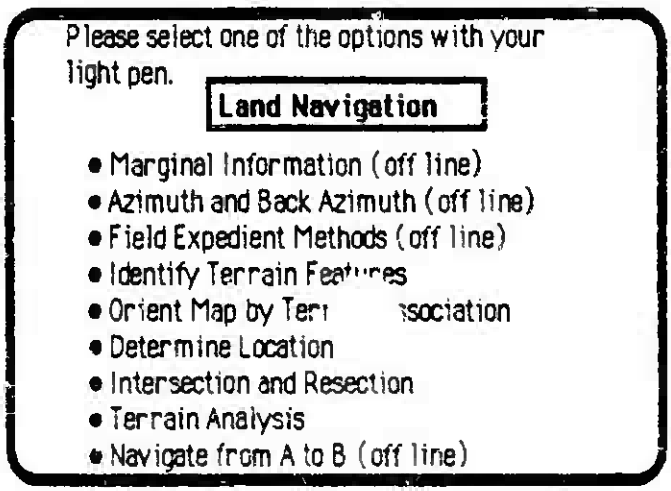
Learning guidelines specific to task categories

In addition to the general learning guidelines, which apply to all of the land navigation tasks, TECEP provides guidelines that depend upon the category of the task being trained. However, TECEP has no categories for spatial relations and visualization. The results of the traditional task analysis on the selected tasks revealed that many of the underlying skills and knowledges required in spatial orientation and navigation would be better covered by the addition of spatial relations and visualization categories. Following a literature review, these categories were designed in the same format as the existing TECEP categories. The land navigation tasks represented several different categories; however, it also can be noted that among the five tasks several guidelines are repeated (see Table 2). While the titles of the guidelines were the same, or similar, for the tasks, the application and interpretation were task-specific.

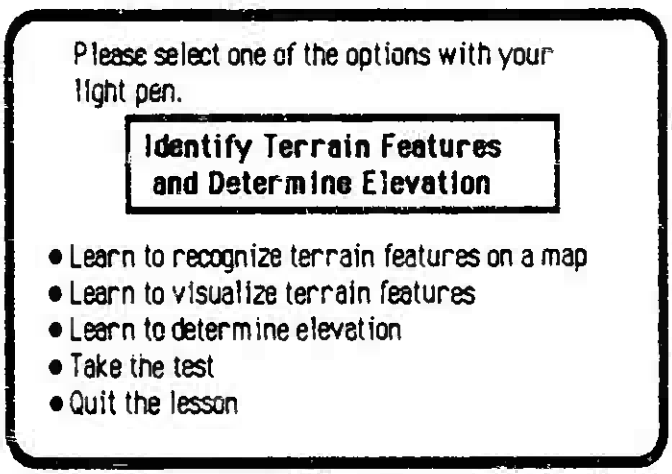
APPENDIX B

Land Navigation Courseware Menus

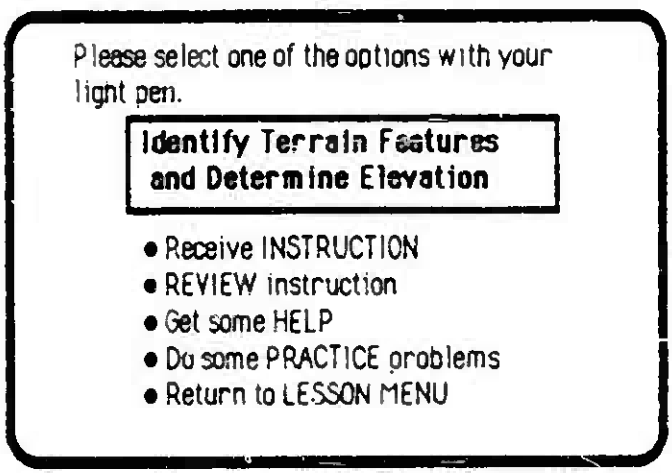
LN.1. Course Menu



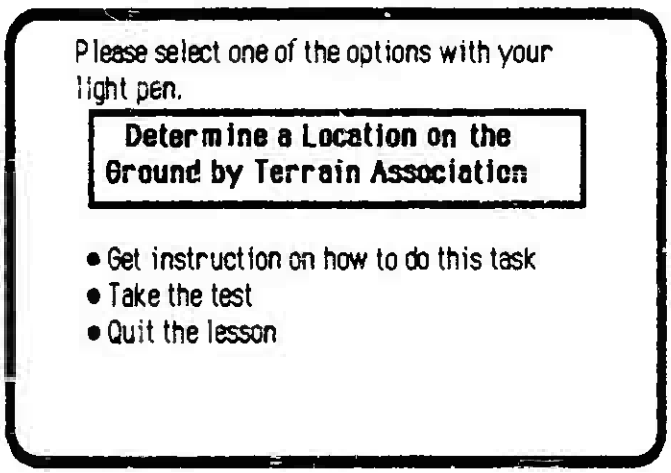
LN.1.1 Lesson Menu



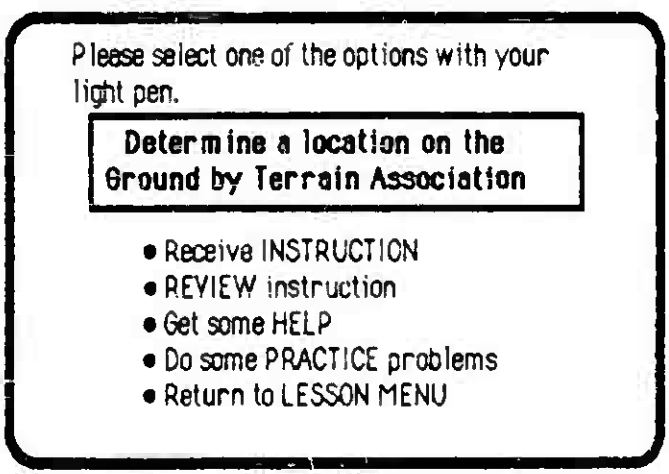
LN.1.1.1 Module Menu



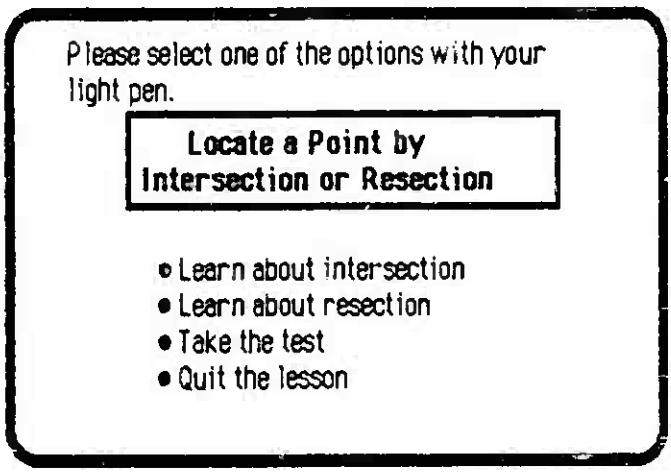
LN.1.3 Lesson Menu



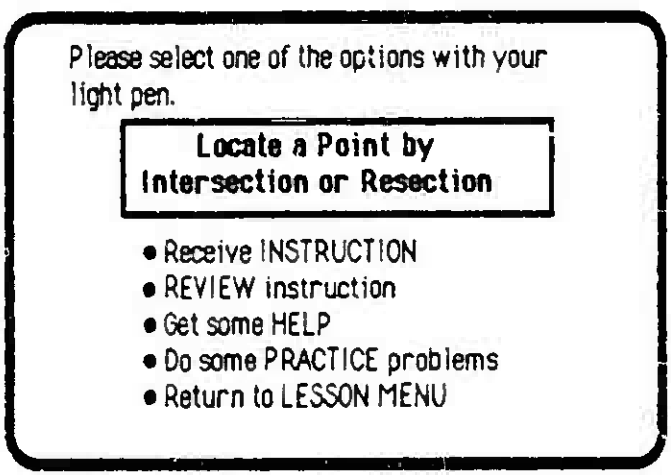
LN.1.3.1 Module Menu



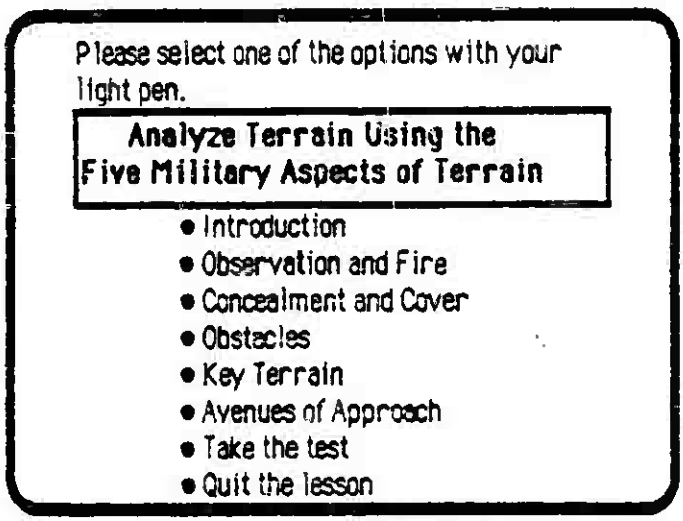
LN.1.4 Lesson Menu



LN.1.4.1 Module Menu



LN.1.5 Lesson Menu



LN.1.5.1 Module Menu